Equilibrium Under the Action of Concurrent Forces

Week 2, Lesson 2

- Critical Friction Force
- Kinetic Friction Force
- Normal Force
- Coefficient of Kinetic Friction
- Coefficient of Static Friction

References/Reading Preparation:
Schaum's Outline Ch. 2
Principles of Physics by Beuche – Ch.4

Friction Forces

Let's look at a book on a table.

When we push **lightly** on it with a horizontal force, it doesn't move.

This force is resisted by the table top with an equal and opposite force.

This equal & opposite force results from the friction between the book and the table and is designated by f.

f opposes the sliding motion of the book and is directed **parallel** to the sliding surface.

If we continue to push on the book, the magnitude of the pushing force reaches a critical value (f_c) and the book begins to move across the surface.

Once the book is moving, a smaller force is required to keep it moving. We designate this force as f_k.

Two types of friction forces are apparent:

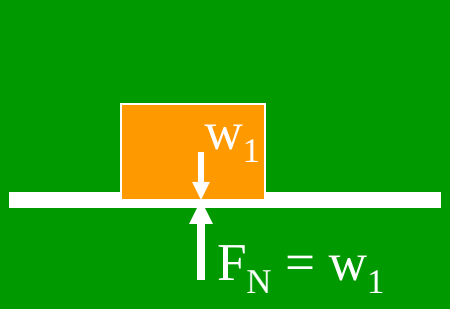
1) The maximum **static friction force** (f_c) must be overcome to start the object moving; and
2) A smaller friction force (f_k) opposes the motion of the sliding object.

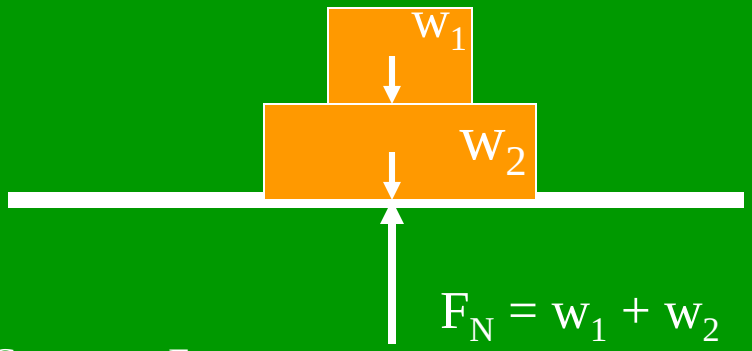
Friction – The Normal Force

From this example we also see that the friction force depends on how forcefully the two surfaces are pushed together. The greater the weight of the object, the greater we must push to get the object moving.

This is called the Normal Force (F_N)

The Normal Force is the perpendicular force a supporting surface exerts on any surface resting on it.





Friction - Continued

Experiments show that f_c and f_k are proportional to F_N.

Also, the condition of the surfaces (whether smooth or rough) also affect the force required to push the book across the surface.

The rougher the surfaces, the greater the force that is required to move the book (or object).

So then,

$f_c = \mu_s F_N$ μ_s = coefficient of static friction

$f_k = \mu_k F_N$ μ_k = coefficient of kinetic friction

SUMMARY

1. The Friction Force (f) is a tangential force on a surface that opposes the sliding of the surface across an adjacent surface. The friction force is parallel to the surface and opposite in direction to its sliding motion.

2. The Normal Force (F_N) on a surface supported by a second surface is the component of the supporting force that is perpendicular to the surface being supported.

3. The coefficient of Static Friction is defined for the case in which one surface is just on the verge of sliding across another surface. It is μ_s = friction force/normal force = f_c/F_N

4. The coefficient of Kinetic Friction is defined for the case in which one surface is sliding across another at constant velocity. It is μ_k = friction force/normal force = f_k/F_N

Let’s do some examples on the board.